

REMARKS

The Applicants sincerely appreciate the thorough examination of the present application as evidenced by the Office Actions of March 28, 2005, and September 16, 2005. In particular, the Applicants appreciate the Examiner's indication that Claims 1-13, 63, 95-109, 111-118, 120, and 123 are allowable; that Claim 113 would be allowable if rewritten in independent form; and that Claim 119 would be allowable if amended to overcome rejections under 35 U.S.C. Sec. 112. In response, the Applicants have amended Claim 78 to more clearly define the claimed invention; amended Claims 119 and 121 to address Section 112 issues noted in the Office Action; and canceled Claim 124. In addition, the Applicants have amended Claims 118 and 132 to address issues relating to antecedent basis noted by the Applicants.

In the following remarks, the Applicants will show that all claims are patentable over the cited art. A Notice of Allowance is thus respectfully requested in due course.

The Subject Matter Of Claims 101 And 133 Is Allowable

The Applicants submit that the subject matter of Claim 101 is allowable because Claim 101 depends from Claim 102 which has been allowed.

In addition, the Applicants believe that the subject matter of Claim 133 is allowable because no rejections have been applied to Claim 133.

All Rejections Under 35 U.S.C. Sec. 112 Have Been Overcome

The Office Action states that Claim 124 is rejected under 35 U.S.C. Sec. 112, first paragraph. Claim 124 has been canceled to advance prosecution of the application. Accordingly, all rejections relating to Claim 124 have been addressed.

The Office states that Claims 121 and 135 are rejected under 35 U.S.C. Sec. 112, second paragraph as being incomplete for omitting several steps. More particularly, the Office Action states that:

The omitted steps are: toward the density of the titanium content. These claims contain the limitation "... the density of titanium in the dielectric layer depends upon the thickness of the dielectric layer...". Although the instant specification further teaches that the density of titanium in the dielectric layer (or layers) is varied within the layer or

between layers, it is unclear how the density of titanium in the dielectric layer depends upon the thickness of the dielectric layer in these claims (metes and bounds).

Office Action, page 3.

With respect to Claim 121, the Applicants have amended Claim 121 to address the noted objection and to address other informalities (relating to antecedent basis) noted therein.

Accordingly, all rejections under 35 U.S.C. Sec. 112 relating to Claim 121 have been overcome.

With respect to Claim 135, the Applicants believe that the Office Action is in error because Claim 135 does not include any recitations relating to a density of titanium.

Accordingly, Claim 135 has not been amended.

In addition, page 11 of the Office Action states that Claim 119 would be allowable if rewritten or amended to overcome the rejection(s) under 35 U.S.C. Sec. 112, 2nd paragraph, set forth in this Office Action. In response, Claim 119 has been amended to address issues relating to clarify first and second densities of titanium that are different, and to address informalities relating to antecedent basis.

The Applicants thus submit that all rejections under 35 U.S.C. Sec. 112 have been addressed and overcome. In addition, the Applicants have amended Claims 118 and 132 to address informalities relating to antecedent basis noted therein.

All Claim Objections Have Been Overcome

The Office Action states that Claims 121 and 135 are objected to because these claims recite "760mTorr" and because the Office Action states that these claims should read "760mmTorr." The Applicants respectfully submit that Claim 121 and 135 correctly recite "760mTorr", and that no amendment is thus required. In particular, a mTorr is a proper abbreviation for a milliTorr which is equivalent to one one-thousandth of a Torr. Accordingly, the Applicants respectfully request that all claim objections be withdrawn.

Claims 78 And 125-136 Are Patentable

Claims 78 and 125-132, and 134-136 have been rejected under 35 U.S.C. Sec. 102(b) as being anticipated by U.S. Patent No. 6,640,403 to Shih *et al.* (Shih). As set forth above,

Independent Claim 78 has been amended to clarify that "a density of titanium of the second tantalum titanium oxide film is higher than the density of titanium of the first tantalum titanium oxide film." Claim 78 is patentable over Shih for at least the reasons discussed below.

As amended, Claim 78 recites a method for manufacturing a semiconductor memory device, the method including:

- (a) forming a lower electrode on an upper surface of the semiconductor substrate;
- (b) forming a reaction suppressing layer on an upper surface of the lower electrode;
- (c) forming a first tantalum titanium oxide film on an upper surface of the reaction suppressing layer;
- (d) forming a second tantalum titanium oxide film on an upper surface of the first tantalum titanium oxide film;
- (e) applying a thermal process to the first and the second tantalum titanium oxide films under an oxygen atmosphere; and
- (f) forming an upper electrode on an upper surface of the second tantalum titanium oxide film,

wherein a density of titanium is adjusted to be 0.1 to 15 percent when the first tantalum titanium oxide film is formed and a density of titanium of the second tantalum titanium oxide film is higher than the density of titanium of the first tantalum titanium oxide film.

With respect to Figure 1 of Shih, Shih discusses a structure including a $(\text{Ta}_2\text{O}_5)_{1-x}(\text{TiO}_2)_x$ thin film 114 between a dielectric layer 112 (that is silicon nitride) and a conductive layer 116. See, Shih, col. 2, lines 39-41. Shih, however, fails to teach or suggest forming first and second tantalum titanium oxide films, much less first and second tantalum titanium oxide films having different densities of titanium, or a second tantalum titanium oxide film having a higher density of titanium than a first tantalum titanium oxide film.

For at least the reasons discussed above, Shih fails to teach or suggest the recitations of Claim 78, and Claim 78 is thus patentable. In addition, dependent Claims 125-136 are patentable at least as per the patentability of Claim 78 from which they depend.

Claims 121 And 122 Are Patentable

Claims 121 and 122 have been rejected under 35 U.S.C. Sec. 102(b) as being anticipated by U.S. Patent No. 6,640,403 to Shih *et al.* (Shih). As set forth above, Independent Claim 121

has been amended to clarify that "a density of titanium of the second tantalum titanium oxide film is higher than the density of titanium of the first tantalum titanium oxide film." Claim 121 is patentable over Shih for at least the reasons discussed below.

As amended, Claim 121 recites a method for manufacturing a semiconductor memory device, the method including:

- (a) forming a lower electrode on an upper surface of a semiconductor substrate;
- (b) forming a dielectric layer of a oxide film including titanium and tantalum, on an upper surface of the lower electrode in a reactor; and
 - (c) forming an upper electrode on an upper surface of the dielectric layer,
 - wherein, in step (b), the dielectric layer has a first density of titanium adjacent the lower electrode and wherein the dielectric layer has a second density of titanium adjacent the upper electrode and wherein the first and second densities of titanium are different;
 - wherein, in step (b), the first and second densities of titanium are in the range of 0.1 to 15 percent;
 - wherein, in step (b), a tantalum precursor and a titanium precursor are mixed outside of the reactor and wherein a mixture of the tantalum and titanium precursors is supplied into the reactor;
 - wherein the dielectric layer is formed at a temperature of 100 to 700° and a pressure of 100 to 760mTorr.

As discussed above with respect to Claim 78, Shih discusses a structure (illustrated in Figure 1 thereof) including a $(\text{Ta}_2\text{O}_5)_{1-x}(\text{TiO}_2)_x$ thin film 114 between a dielectric layer 112 (that is silicon nitride) and a conductive layer 116. *See*, Shih, col. 2, lines 39-41. Shih, however, fails to teach or suggest a tantalum titanium oxide film having a first density of titanium adjacent a lower electrode and having a second density of titanium adjacent an upper electrode, wherein the first and second densities of titanium are different.

For at least the reasons discussed above, Shih fails to teach or suggest the recitations of Claim 121, and Claim 121 is thus patentable. In addition, dependent Claim 122 is patentable at least as per the patentability of Claim 121 from which it depends.

Attorney Docket No. 5649-1073

Application No.: 10/616,056

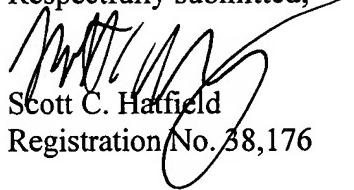
Filed: July 9, 2003

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CONCLUSION

Accordingly, the Applicants submit that all pending claims in the present application are in condition for allowance, and a Notice of Allowance is respectfully requested in due course. The Examiner is encouraged to contact the undersigned attorney by telephone should any additional issues need to be addressed.

Respectfully submitted,

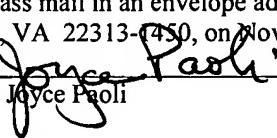

Scott C. Hatfield
Registration No. 38,176

Customer Number 20792

Myers Bigel Sibley & Sajovec, P.A.
P.O. Box 37428
Raleigh, NC 27627
919-854-1400
919-854-1401 (Fax)

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Signature: 
Joyce Paoli